VILNIUS TECH
Vilnius Gediminas Technical University

Proceedings of the 13th International Scientific Conference

ENVIRONMENTAL ENGINEERING

April 23–24, 2026, Vilnius, LITHUANIA

eISSN 2029-7092
eISBN 978-609-476-444-8
Article ID: enviro.2026.1695
https://doi.org/10.3846/enviro.2026.1695

DETERMINATION OF PUBLIC TRANSPORT ORGANIZATION INDICATORS AND ASSESSMENT OF THEIR IMPORTANCE

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Received 12 February 2026; revised 24 February 2026; accepted 24 February 2026

Abstract. Public transport plays a vital role in urban mobility, ensuring accessibility, sustainability and the economic development of cities and regions. To achieve these goals, it is important to systematically monitor and evaluate performance, ideally using real-time, daily data. Performance indicators are quantitative and qualitative measures used to assess different aspects of a public transport system, including reliability, safety, environmental impact, fleet management and operational efficiency (for example, in the selection process of operators). However, not all of these indicators are equally important and must be assessed comprehensively. Determining the relative importance of each indicator helps organizations to focus on the aspects that best meet their policy objectives and customer expectations. This paper synthesizes current research to outline key service indicators and explores the disparities in public transport delivery across diverse urban landscapes.

Keywords: accessibility, indicators, quantitative measures, qualitative measures, public transport (PT), reliability, urban mobility.

1. Introduction

Public transport systems serve as the backbone of urban infrastructure, should play a significate role in reducing traffic congestion, lowering greenhouse gas emissions, and ensuring equitable access to mobility. To optimize these systems, their effectiveness must be assessed through a multi-dimensional framework of indicators, such as operational performance, service quality, environmental sustainability, and user satisfaction. Indicators monitoring must be based on actual and reliable data.

However, the efficacy of these services varies significantly across cities and metropolitan regions, influenced by factors such as population density, governance structures, and socio-economic environment. This paper synthesizes current research to outline key service indicators and explores the disparities in public transport delivery across diverse urban landscapes. By analysing these available data and regional differences, manuscript provides insights for policymakers and urban planners aiming to enhance system performance and meet the evolving needs of metropolitan populations.

The effectiveness of public transport systems is not basic and monitored by a one or two simple metrics / variables, but rather a multi-dimensional construct having operational, environmental, and social domains. By synthesizing the indicators chosen, we establish a holistic framework where technical metrics are linked to broader socio-economic outcomes.

2. Public transport service indicators

The article was prepared by selecting literature sources (articles, conference materials, studies) based on keywords, examining the organization of public transport services and the quantitative and qualitative assessment of these processes. The Lithuanian experience was assessed based on public open data sources, public documents, such as how 5 large Lithuanian cities assess non-financial indicators of public transport services in their letters of expectations to institutions providing of organizing public transport services.

The data show that technical indicators such as the number of trips and other demand indicators cannot be analysed without context; they are fundamentally linked to the satisfaction of residents and accessibility. For example, accessibility indicators are a key tool for assessing whether a system provides fair mobility for different populations.

Furthermore, decision-making (data based) and implementation integration are key factors in translating these indicators into actionable policies. This ensures that service performance optimization, such as improving frequency or coverage, is not done in isolation but is closely aligned with sustainability practices and responds to the user.

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Finally, understanding the regional differences in these indicators is essential for policy makers seeking to address the specific socio-economic needs of their metropolitan areas.

Literature analysis shows taxonomy of public transport (PT) service indicators generally in 4 fields (see Figure 1).

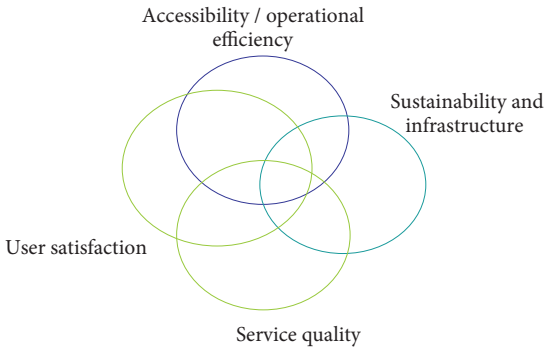

Figure 1. Taxonomy of PT service indicator (compiled by the author after evaluating literature sources)

Accessibility: mainly utilizing accessibility data to evaluate service equity and connectivity ("door to door", "first/last mile").

Sustainability and infrastructure: integration of sustainability measures with technological and infrastructure systems.

Service Quality: analysis of ridership demand, operational efficiency, and service quality indicators.

User satisfaction data: examining user behaviour, satisfaction norms, and the general user experience.

3. Public transport service indicators

The literature review presents a few studies that analyse various indicators and their importance in more detail.

3.1. Accessibility

Accessibility is a fundamental indicator of public transport service effectiveness, basically representing how easily residents/customers can reach their various destinations using public transport networks. It measures the spatial and temporal reach of mass transport services. Spatial reach is often assessed through metrics such as the proximity of the population to stations and the frequency of service. Temporal reach can be evaluated by considering factors such as service hours, waiting times, and the regularity of departures throughout the day timelines.

Studies of accessibility indicator reveals contrasting results based on accessibility measures, revealing that certain demographics, particularly households with children, experienced notably lower accessibility levels (Albacete et al., 2015).

Things like age, income, reason to travel don't really change how far resident walks. Instead, the type of transport and how often stops are spaced matter most. So, solutions to improve access might need to be different depending on transport mode (for example whether it's buses or trains) (Daniels & Mulley, 2013).

Numerous methods exist for measuring accessibility, including infrastructure equipment indicators, distance measurement, cumulative (isochronous) methods, which measure accessibility based on the number of opportunities reachable within a certain time frame potential models. By blending these methods, planners can move from simple distance measurements to personified accessibility models. This ensures that a "300 m walk" isn't just a spatial metric, but an equitable one that considers the socioeconomic reality of the user, the frequency of the vehicle, and the density of the destination (Żochowska et al., 2022).

In two other studies, Guzmán et al. (2017) show that structural inequalities in transport accessibility in regions such as Bogotá can intensify social exclusion among residents living in peripheral areas, while Rocha et al. (2023) emphasize that these inequalities are also mirrored in users' perceptions. In the Porto Metropolitan Area in particular, perceived service quality is strongly shaped by the municipality of residence and household attributes, indicating that fair transit planning must tackle both the objective gaps in accessibility and the subjective experiences of different user groups.

The study (Bok & Kwon, 2016) provides a viable methodology and integrated indicator for measuring and comparing public transport accessibility in metropolitan areas, incorporating both spatial and temporal dimensions using GTFS data and ambient population. Over 10,000 transit agencies worldwide now use GTFS to share their schedules and geographic information, these agencies are spread across more than 100 countries (https://gtfs.org/). There are currently over 4,000 active, open-access feeds catalogued in major repositories (like the Mobility Database), which include GTFS Schedule, GTFS Realtime, and GBFS (https://mobilitydatabase.org/faq).

Comparison results show that a significantly larger share of the population in the urban core areas of European metropolitan areas has access to public transit. The relative density and number of stops for different modes affect accessibility. For instance, buses were found to be the most highly accessible transit mode because bus stops heavily outnumber those of any other transit mode in every examined and pedestrian walking distances (Bok & Kwon, 2016).

3.2. Service quality

Service quality is essential for ensuring user satisfaction. Key performance indicators (KPIs) include punctuality, reliability, and the overall effectiveness of the service provided.

Punctuality, as a measure of timeliness, is critically associated with passenger satisfaction. Studies indicate that

precise definitions of punctuality can vary significantly based on passenger perceptions. Punctuality is a crucial measure for public transport network performance, significantly impacting passenger satisfaction and perceived service quality (Reijsbergen & Gilmore, 2014).

Timeliness can be quantified through the on-time rate and departure index, which reflect the punctuality of services provided (see example on Figure 2). These measures are not only indicators of operational performance but also have strategic implications for urban planning and community satisfaction. The raw GPS data includes vehicle code, line code, direction, GPS time, coordinates (longitude and latitude in WGS-84), running status, parking status, and update time. Case analysis uses GPS and vehicle scheduling data (Xiaoliang & Limin, 2021).

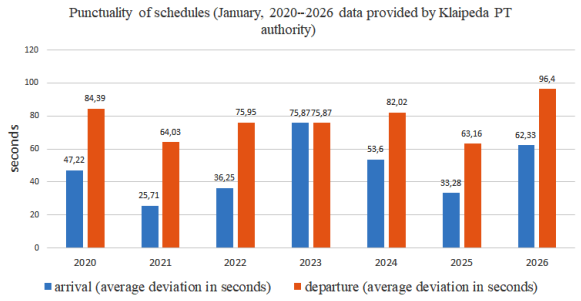

Figure 2. Average punctuality, deviation in seconds (Klaipeda Public Transport Authority, n.d.)

3.3. Sustainability

Sustainability indicators assess the environmental impact and operational sustainability of public transport systems. Essential metrics include emissions, energy consumption, and operational costs.

The sustainability framework identifies environmental, technical, economic, and social factors that should be closely monitored. Despite variety of aspects s such as travel time, cost, expenses, accessibility, traffic flow etc., environmental factors like emissions and energy consumptions is the single highest-frequency indicator across the four dimensions found in the literature reviewed for evaluating the sustainability of public transportation (Al-lami & Török, 2023).

Recent development efforts have underscored the significance of integrating sustainability metrics: 1) low emissions (GHS emissions, air pollution (PM, NOx, SOx), noise pollutions, use of renewable energy, use of innovative technologies); 2) efficient use of resources (emission per passenger, efficient energy use, amount of waste) with traditional efficiency measurements to guide planning and decision-making processes (Karjalainen & Juhola, 2019).

3.4. User satisfaction

Understanding user behaviour is essential for optimizing public transport operations. Data analytics can provide insights into the time-space habits of customers, informing service adjustments and promoting efficient routing and scheduling.

Data analytics, which transforms field data into insightful information for process optimization and decision support. The proposed ethical framework for Big Data aims to provide six major benefits for public transportation, including improving pricing, saving costs, meeting customer demands, optimizing routes/schedules, offering additional services, and reducing downtime (Chang, 2021).

Research suggests that employing data-driven approaches can help public transport organizations tailor their services to meet the fluctuating demand patterns effectively, thus improving operational outcomes and increasing ridership. Two variables, travel time and the ratio of trips, are employed to calculate the accessibility index, and comparative assessments between zones are conducted. The application of smart card data makes it possible to analyse travel information and reflect them empirically in the model (Yun et al., 2021).

4. Public transport KIP's in Lithuania

The research covers the public transport systems of 5 major Lithuanian cities. In 3 cities (Vilnius, Klaipėda and Panevėžys), the systems are organized by public transport agencies/authorities, and services are provided by both municipally managed operators and those selected through tenders. In Kaunas and Šiauliai, the organization and provision of the service is handled by a municipally managed operator. The analysis compared public documents which are common for all 5 cities. The mayor of each municipality approved the letters of expectations (Mayor of Vilnius / Kaunas / Klaipėda / Šiauliai / Panevėžys cities municipalities), which set out the non-financial indicators (KPI's) of the public transport system (see Table 1). In addition, the public transport systems of large cities are assessed in the general Lithuanian context, according to the public data available from the Ministry of Transport of the Republic of Lithuania, emphasizing the environmental trends of "greening" the service.

All 5 cities have one common service quality indicator – the number of trips. However, this metric differs – 2 cities consider the total annual number of trips, Šiauliai – the number of trips per working day, the remaining two – the number of trips per 1 capita. Knowing one indicator, you can derive the other. Best scenario is to keep tracking both, total annual number of trips focuses on operational, financial aspects showing system load, network scale, fleet needs. While number of trips per capita reflects system social benefits, engagements of residents, accessibility equity and allows comparison among cities of different sizes.

Knowing the facts that all cities have implemented electronic ticket solutions, additional benefits could be generated by statistics (validations) of unique e-ticket

carriers (see Figure 3), which would constantly show the number of residents using public transport services and would be an additional data source for the analysis the modal split of transport modes.

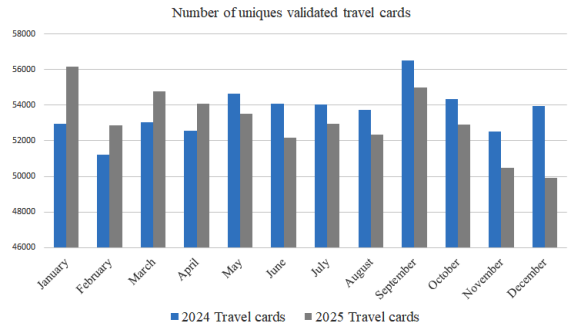

Figure 3. Number of validated unique travel cards per month 2024/2025 (Klaipeda Public Transport Authority, n.d.)

Customer satisfaction with public transport is assessed slightly differently: the index is obtained through a survey method (scale from 1 to 10) or through a service reliability indicator (proportion of undelivered service – 0.2/0.4%).

Accessibility in 2 cities is assessed not within the city limits (public data on https://m.stops.lt/ shows that the density of stops in all 5 cities largely meets the recommended norms), but through regional integration, addressing problems with the organization of public transportation in the suburban area as well. Regional municipalities are trapped in a closed cycle, the scope of public transport services differs from that of a large city, therefore the attention to organization and maintenance issues is relatively less. In this way, sufficient attention is no longer paid to public transport planning, analysis of schedules and routes, and it is difficult to ensure the availability of specialists with all the necessary competencies. It is financially too expensive for municipalities to purchase and use specialized public transport management programs, to accumulate and constantly analyse at least minimal data. Regional integration by connecting regional centers with the nearest neighbouring municipalities would unify the provision of services.

Sustainability indicators (proportions of polluting/ non-polluting/less polluting mileage/ fleet by fuel type and fleet age) are mentioned in the documents of 2 cities. But additionally, we can compare the data for this indicator according to the public sustainable mobility data of the Ministry of Transport and Communications of the Republic of Lithuania – collected about 57 municipalities with total fleet of 3 098 vehicles. The data collected by the Ministry of Transport and Communications (since 2024) show that large cities (see Table 2 and Figures 4–5) with the largest public service volumes are strategically paying attention to environmental aspects. Although this is not equally analysed in the expectation statements, the derived data show that the proportion of the most polluting mileage is no longer dominant.

Table 1. Main KPI's for PT service in 5 biggest cities in Lithuania

	Vilnius	Kaunas	Klaipėda	Šiauliai	Panevėžys
Service quality					
Annual / day trips	x	x		x	
Trips per capita			x		x
PT speed, Km/h		x	x		
User satisfaction data					
Satisfaction	x			x	x
Reliability, %		x	x	x	
Accessibility					
Regional integration, no of lines			x		x
Sustainability and infrastructure					
Fleet age			x	x	
Diesel mileage			x	x	

Table 2. PT fleet by fuel type in 5 biggest cities in Lithuania (data status 2025-11-27, Sustainable mobility data, Ministry of Transport and Communications of the Republic of Lithuania, 2025)

	Vilnius	Kaunas	Klaipėda	Šiauliai	Panevėžys
Fleet by fuel type					
Diesel	398	200	139	31	46
CNG/ LPG/ LNG	136	99	69	89	25
E-buses	22		90		
Trolleybuses	347	143			
Fleet age, average					
Fleet age	9	8.4	8.8	12.5	14.2

The supported transport mode in Vilnius and Kaunas – trolleybuses, and the growing share of electric buses significantly contribute to the GHG reduction goals. Less polluting (running on natural gas) mileage also plays an important role – it amortizes the costs of greening the transport fleet and acts as a reliable alternative that reduces risks to the reliability of public transport services.

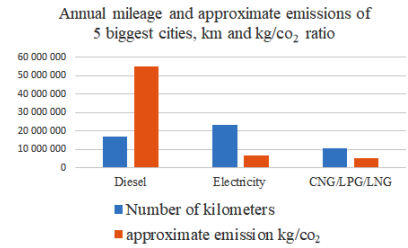

Figure 4. Annual service mileage and emission ratio in 5 biggest Lithuanian cities (data status 2025-11-27, Sustainable mobility data, Ministry of Transport and Communications of the Republic of Lithuania, 2025)

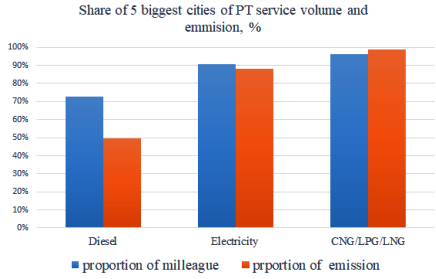

Figure 5. Share of service mileage and emission in 5 biggest Lithuanian cities (data status 2025-11-27, Sustainable mobility data, Ministry of Transport and Communications of the Republic of Lithuania, 2025)

5. Conclusions

1. Public transport executives should implement an integrated assessment framework that systematically combines operational, environmental, and social indicators. Such a framework enables a more comprehensive evaluation of system performance and supports decision-making processes with empirically robust evidence.

2. Transport planners and policymakers should prioritise the enhancement of accessibility for all user groups, with particular emphasis on residents of peripheral and underserved areas. Assessment methodologies must explicitly account for spatial and temporal dimensions, as well as socio-economic characteristics and user perceptions, in order to ensure equitable and socially inclusive mobility outcomes.

3. Resources should be allocated to advanced data analytics solutions, including the systematic use of smart card data and real-time Global Positioning System (GPS) tracking, to monitor punctuality, service reliability, and user satisfaction. The application of these tools facilitates a more precise alignment of service provision with observed demand patterns and contributes to improvements in operational efficiency.

4. The transition towards low- and zero-emission vehicle fleets – such as electric buses, trolleybuses, and gas-powered vehicles – should be maintained and accelerated. Emissions, energy consumption, and fleet composition should be monitored at regular intervals to ensure consistency with environmental targets and to promote sustainable urban mobility.

5. Inequalities between central urban districts and suburban or peri-urban areas should be reduced by fostering stronger regional integration and harmonized transport and land-use planning. Inter-municipal cooperation and investments in shared governance and management platforms are likely to reduce disparities in both service quality and accessibility.

6. Structured, real-time monitoring systems for key performance indicators should be developed and institutionalised. The systematic use of high-quality data will enable continuous adaptation of strategies and timely responses to evolving user needs, thereby supporting the ongoing improvement and optimization of public transport networks.

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